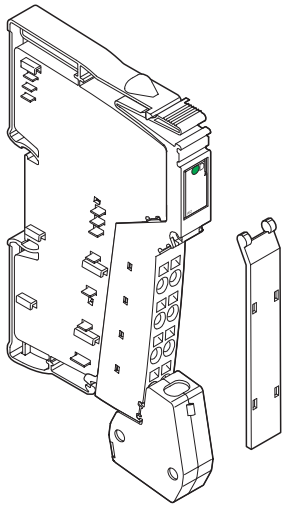
IB IL AI 2/SF (-PAC)



Inline Terminal
With 2 Analog Input Channels

AUTOMATIONWORX

Data Sheet
5564_en_03

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1 Description

The terminal is designed for use within an Inline station.
It is used to acquire analog voltage or current signals.

Features

- Two analog single-ended signal inputs for the connection of either voltage or current signals
- Connection of sensors in 2 and 3-wire technology
- Three current measuring ranges:
  0 mA to 20 mA, ±20 mA, 4 mA to 20 mA
- Two voltage measuring ranges:
  0 V to 10 V, ±10 V
- Channels are configured independently of one another using the bus
- Measured values can be represented in four different formats
- Resolution depends on the representation format and the measuring range
- Process data update of both channels in 1.5 ms, maximum
- Diagnostic indicators

This data sheet is only valid in association with the IB IL SYS PRO UM E user manual or the Inline system manual for your bus system.

Make sure you always use the latest documentation.
It can be downloaded at www.download.phoenixcontact.com.

A conversion table is available on the Internet at
www.download.phoenixcontact.com/general/7000_en_00.pdf.

This data sheet is valid for the following products listed on page 3.

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2 Ordering Data

Products

Description	Type	Order No.	Pcs./Pkt.
Inline terminal with 2 analog input channels, including accessories (connector and labeling field	IB IL AI 2/SF-PAC	2861302	1
Inline terminal with 2 analog input channels, without accessories	IB IL AI 2/SF	2726285	1

The listed connector is needed for the complete fitting of the IB IL AI 2/SF terminal.

Accessories

Description	Type	Order No.	Pcs./Pkt.
Shield connector, without colour identification for analog Inline terminals	IB IL SCN-6 SHIELD-TWIN	2740245	5

Documentation

Description	Type	Order No.	Pcs./Pkt.
User manual: "Configuring and Installing the INTERBUS Inline Product Range"	IB IL SYS PRO UM E	2743048	1
User manual: "Automation Terminals of the Inline Product Range"	IL SYS INST UM E	2698737	1
Application note: "InlineTerminals for Use in Zone 2 Potentially Explosive Areas"	AH EN IL EX ZONE 2	7217	–

3 Technical Data

General Data	
Housing dimensions (width x height x depth)	12.2 mm x 120 mm x 71.5 mm
Weight	47 g (without connector), 69 g (with connector)
Operating mode	Process data mode with 2 words
Connection method for sensors	2 and 3-wire technology
Power supply for the sensors	With an external power supply unit or with an additional segment terminal with a fuse IB IL 24 SEG/F
Permissible temperature (operation)	-25°C to +55°C
Permissible temperature (storage/transport)	-25°C to +85°C
Permissible humidity (operation/storage/transport)	10 % to 95 % according to DIN EN 61131-2
Permissible air pressure (storage/transport)	70 kPa to 106 kPa (up to 3,000 m above sea level)
Degree of protection	IP20 according to IEC 60529
Class of protection	Class 3 according to VDE 0106, IEC 60536
Connection data of connector	
Connection method	Spring-cage terminals
Conductor cross-section	0.2 mm^2 to 1.5 mm^2 (solid or stranded), AWG 24 - 16

Deviations From Common Technical Data That Are Indicated in the IB IL SYS PRO UM E User Manual	
Noise Immunity Test According to EN 50082-2	
Electrostatic discharge (ESD) according to EN 61000-4-2; IEC 61000-4-2	Criterion B 6 kV contact discharge 6 kV air discharge
Mechanical Requirements	
Shock test according to EN 60068-2-27, IEC 60068-2-27	15g load for 11 ms, half sinusoidal wave, three shocks in each space direction and orientation 25g load for 6 ms, half sinusoidal wave, three shocks in each space direction and orientation

Interface	
Local bus	Data routing

Transmission Speed	
IB IL AI 2/SF; IB IL AI 2/SF-PAC	500 kbps

Power Consumption	
Communications power U_L	7.5 V DC
Current consumption from U_L	45 mA (typical); 60 mA (maximum)
I/O supply voltage U_{ANA}	24 V DC
Current consumption at U_{ANA}	13 mA (typical); 18 mA (maximum)
Total power consumption	662 mW (typical); 882 mW (maximum)

Supply of the Module Electronics and I/O Through the Bus Coupler/Power Terminal	
Connection method	Potential routing

Analog Inputs

Number		2 analog single-ended inputs		
Signals/resolution in the process data word (quantization)				
Voltage	0 to 10 V	0 - 10.837 V 0 - 10.000 V 0 - 10.000 V 0 - 10.837 V	(IB IL format) (IB ST format) (IB RT format) (Standardized representation)	0.333 mV/LSB 2.441 mV/LSB 0.305 mV/LSB 1.000 mV/LSB
	±10 V	±10.837 V ±10.000 V ±10.000 V ±10.837 V	(IB IL format) (IB ST format) (IB RT format) (Standardized representation)	0.333 mV/LSB 2.441 mV/LSB 0.305 mV/LSB 1.000 mV/LSB
Current	0 to 20 mA	0 - 21.6746 mA 0 - 20.000 mA 0 - 20.000 mA 0 - 21.6746 mA	(IB IL format) (IB ST format) (IB RT format) (Standardized representation)	0.6666 µA/LSB 4.8828 µA/LSB 0.6105 µA/LSB 1.000 µA/LSB
	±20 mA	±21.6746 mA ±20.000 mA ±20.000 mA ±21.6746 mA	(IB IL format) (IB ST format) (IB RT format) (Standardized representation)	0.6666 µA/LSB 4.8828 µA/LSB 0.6105 µA/LSB 1.000 µA/LSB
	4 to 20 mA	4 - 21.339 mA 4 - 20.000 mA 4 - 20.000 mA 4 - 21.339 mA	(IB IL format) (IB ST format) (IB RT format) (Standardized representation)	0.533 µA/LSB 3.906 µA/LSB 0.4884 µA/LSB 1.000 µA/LSB
Measured value representation		In the following formats: IB IL IB ST IB RT Standardized representation	 (15 bits with sign bit) (12 bits with sign bit) (15 bits with sign bit) (15 bits with sign bit)	

Please read the notes on page 17 and page 21 on measured value representation in "IB IL" and "standardized display" format.

Mean value generation	Over 16 measured values (can be switched off)
Conversion time of the A/D converter	120 µs, approximately

Analog Input Stages

Voltage Inputs

Input resistance	>220 kΩ
Limit frequency (-3 dB) of the input filter	40 Hz
Internal process data update of both channels	<1.5 ms
Behavior upon sensor failure	Goes to 0 V
Maximum permissible voltage between analog voltage inputs and analog reference potential	± 32 V
Common mode rejection (CMR)	90 dB, minimum
Reference: Voltage input signal, valid for permissible DC common mode voltage range	110 dB, typical
Permissible DC common mode voltage for CMR	40 V between voltage input and FE

Analog Input Stages (Continued)	
Current Inputs	
Input resistance	50 Ω (shunt)
Limit frequency (-3 dB) of the input filter	40 Hz
Internal process data update of both channels	<1.5 ms
Behavior upon sensor failure	Goes to 0 mA/4 mA
Maximum permissible voltage between analog current inputs and analog reference potential	±5 V (corresponding with 100 mA across the sensor resistances)
Common mode rejection (CMR)	90 dB, minimum
Reference: Current input signal, valid for permissible DC common mode voltage range	110 dB, typical
Permissible DC common mode voltage for CMR	40 V between current input and FE
Maximum permissible current	±100 mA

Note on the internal process data update:
The time specification also contains the internal firmware runtime and the time for analog/digital conversion of the module. For system inspection (e.g., for step-response determination of sensors), please also observe the times for latching and bus transmission as well as the status of the mean-value generation.

Tolerance Behavior and Temperature Response of the Voltage Inputs (The tolerance indications refer to the measuring range final value of 10 V.)	Typical	Maximum
Tolerance at 23°C		
Tolerance due to offset	±0.03%	±0.06%
Tolerance due to increase	±0.05%	±0.10%
Differential non-linearity	±0.10%	±0.20%
Total tolerance of the voltage inputs at 23°C Tolerance due to offset, increase and linearity	±0.15%	±0.30%
Temperature response at -25°C to +55°C		
Offset drift T_{KVO}	±6 ppm/K	±12 ppm/K
Gain drift T_{KG}	±30 ppm/K	±50 ppm/K
Total voltage drift $T_{Ktot} = T_{KVO} + T_{KG}$	±36 ppm/K	±62 ppm/K
Total error of the voltage inputs (-25°C to +55°C) Tolerance due to offset, increase, linearity, and drift	±0.30%	±0.50%

Tolerance Behavior and Temperature Response of the Current Inputs (The tolerance indications refer to the measuring range final value of 20 mA.)	Typical	Maximum
Tolerance at 23°C		
Tolerance due to offset	±0.03%	±0.06%
Tolerance due to increase	±0.10%	±0.10%
Differential non-linearity	±0.10%	±0.30%
Total tolerance of the current inputs at 23°C Tolerance due to offset, increase and linearity	±0.20%	±0.40%
Temperature Response at -25°C to +55°C		
Offset drift T_{KIO}	±6 ppm/K	±12 ppm/K
Gain drift T_{KG}	±30 ppm/K	±50 ppm/K
Total drift $T_{Ktot} = T_{KIO} + T_{KG}$	±36 ppm/K	±62 ppm/K
Total error of the voltage inputs (-25°C to +55°C) Tolerance due to offset, increase, linearity and drift	±0.35%	±0.60%

Additional Tolerances Influenced by Electromagnetic Fields

Type of Electromagnetic Interference	Typical Deviation of the Measuring Range Final Value (Voltage Input)		Typical Deviation of the Measuring Range Final Value (Current Input)	
	Relative	Absolute	Relative	Absolute
Electromagnetic fields; Field strength 10 V/m according to EN 61000-4-3/IEC 61000-4-3	< ±2%	< ±200 mV	< ±2%	< ±400 µA
Conducted interference Class 3 (test voltage 10 V) according to EN 61000-4-6/IEC 61000-4-6	< ±1%	< ±100 mV	< ±1%	< ±100 µA
Fast transients (burst) 4 kV supply, 2 kV input according to EN 61000-4-4/IEC 61000-4-4	< ±1%	< ±100 mV	< ±1%	< ±100 µA

Safety Equipment

Surge voltage	Suppressor diodes in the analog inputs

Electrical Isolation/Isolation of the Voltage Areas

To provide electrical isolation between the logic level and the I/O area, it is necessary to supply the station bus coupler and the sensors connected to the analog input terminal, from separate power supply units. Interconnection of the power supply units in the 24 V area is not permitted (see also user manual).

Common Potentials

The 24 V main voltage, 24 V segment voltage, and GND have the same potential.
FE is a separate potential area.

Separate Potentials in the System Consisting of Bus Coupler/Power Terminal and I/O Terminal

- Test Distance	- Test Voltage
5 V supply incoming remote bus / 7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min
5 V supply outgoing remote bus / 7.5 V supply (bus logic)	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic) / 24 V supply U_{ANA} / I/O	500 V AC, 50 Hz, 1 min
7.5 V supply (bus logic) / 24 V supply U_{ANA} / functional earth ground	500 V AC, 50 Hz, 1 min
I/O / functional earth ground	500 V AC, 50 Hz, 1 min

Error Messages to the Higher-Level Control or Computer System

Failure of the internal voltage supply	Yes
Peripheral fault / user error	Yes, error message via the IN process data (see page 16)

Approvals

For the latest approvals, please visit www.download.phoenixcontact.com.

4 Local Diagnostic/Status Indicators and Terminal Point Assignment

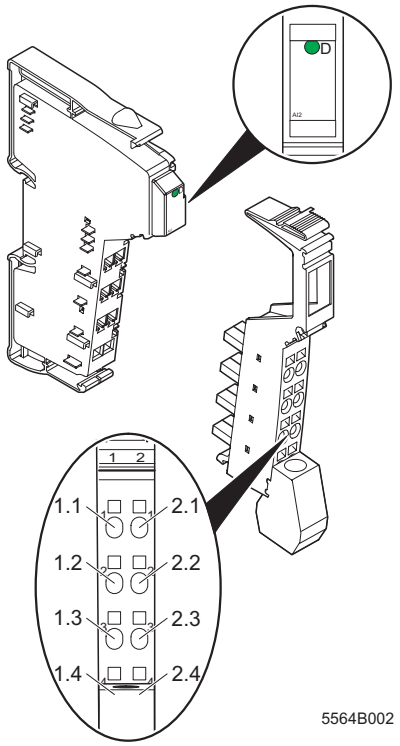

Figure 1 The terminal with the appropriate connector

4.1 Local Diagnostic and Status Indicators

Des.	Color	Meaning
D	Green	Diagnostics

4.2 Function Identification

Green

4.3 Terminal Point Assignment

Terminal Points	Signal	Assignment
1.1	**+U1**	Voltage input channel 1
2.1	**+U2**	Voltage input channel 2
1.2	**+I1**	Current input channel 1
2.2	**+I2**	Current input channel 2
1.3	**-1**	Minus input for channel 1 (common for current and voltage)
2.3	**-2**	Minus input for channel 2 (common for current and voltage)
1.4, 2.4	**Shield**	Shield connection

5 Installation Instructions

High current flowing through potential jumpers U_M and U_S increases the temperature of the potential jumpers and the inside of the terminal. Note the following instructions to keep the current flowing through the potential jumpers of the analog terminals as low as possible:

Create a separate main circuit for each analog terminal.

If this is not possible in your application and you are using analog terminals in a main circuit together with other terminals, place the analog terminals behind all the other terminals at the end of the main circuit.

6 Internal Circuit Diagram

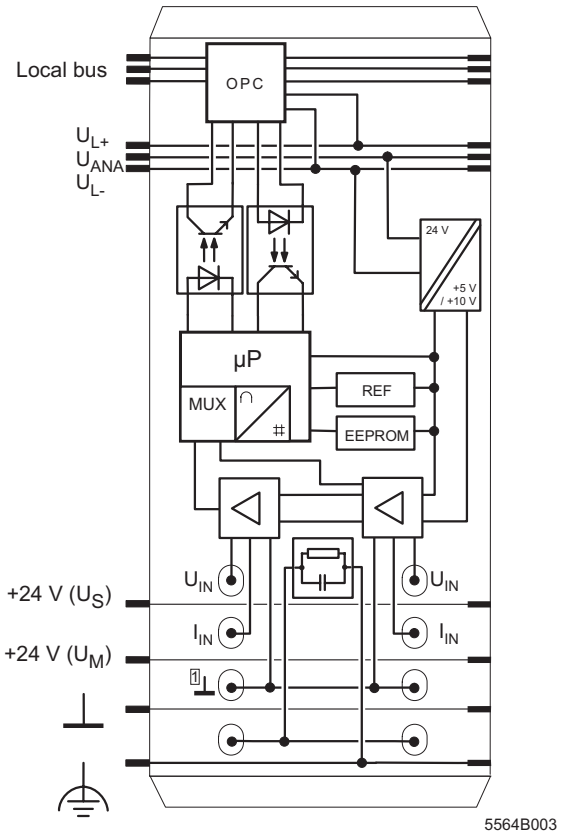

Figure 2 Internal wiring of the terminal points

Key:

OPC	Protocol chip
	Optocoupler
	Power supply unit with electrical isolation
µP MUX	Microprocessor with multiplexer and analog-to-digital converter
REF	Reference voltage
EEPROM	Electrically erasable programmable read-only memory
	Amplifier
	Coupling network

Other symbols used are explained in the IB IL SYS PRO UM E user manual or in the Inline system manual for your bus system.

7 Electrical Isolation

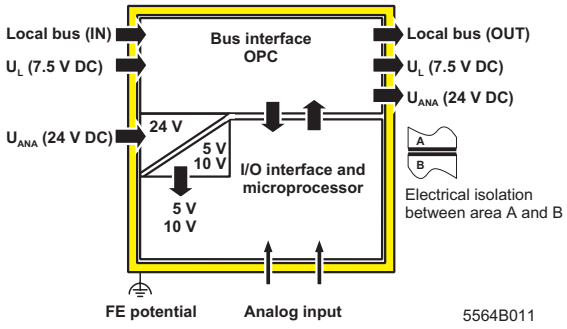

Figure 3 Electrical isolation of the individual function areas

8 Connection Notes

Do not connect voltages above ±5 V to a current input. This damages the module electronics as the maximum permissible current of ±100 mA is exceeded.

Always connect the analog sensors using shielded, twisted pair cables.

Connect the shielding to the terminal using the shield connection clamp. The clamp connects the shield with high resistance and with a capacitor to FE on the module side. Additional wiring is not necessary.

Connect the shielding of the sensor with PE potential.

9 Connection Examples

Use a connector with shield connection when installing the sensors. Figure 4 and Figure 5 show the connection schematically (without shield connector).

9.1 Connection of Active Sensors

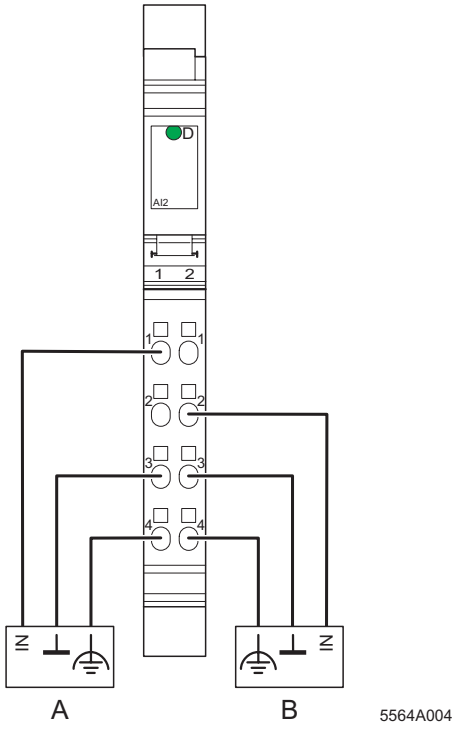

Figure 4 Connection of active sensors in 2-wire technology with shield connection

A Active sensor with voltage output (channel 1)

B Active sensor with current output (channel 2)

9.2 Connection of Passive Sensors

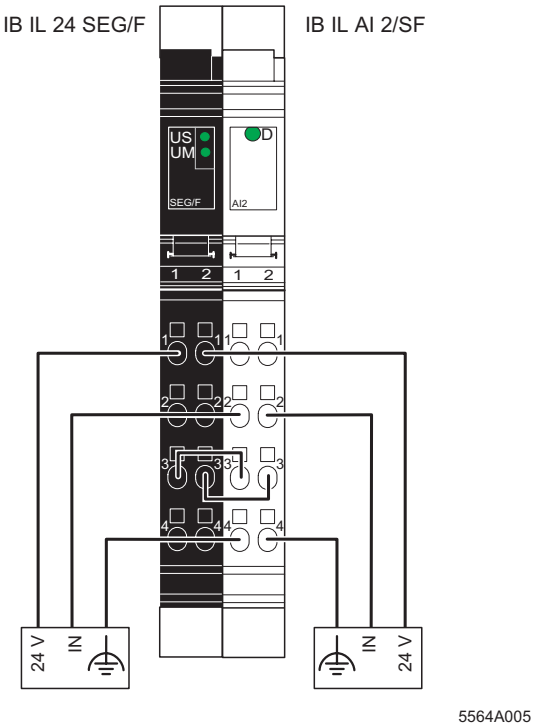

Figure 5 Connection of 2 passive sensors in 2-wire technology with shield connection

Figure 5 shows the passive sensor supply. The sensors are supplied through a pre-connected segment terminal with a fuse. The sensors can also be supplied from an external power supply unit.

9.3 Connection for Battery Monitoring

Both reference inputs (minus inputs) of each terminal are connected to each other. If signal sources are connected in series, wrong connections can lead to a short circuit of individual signal sources.

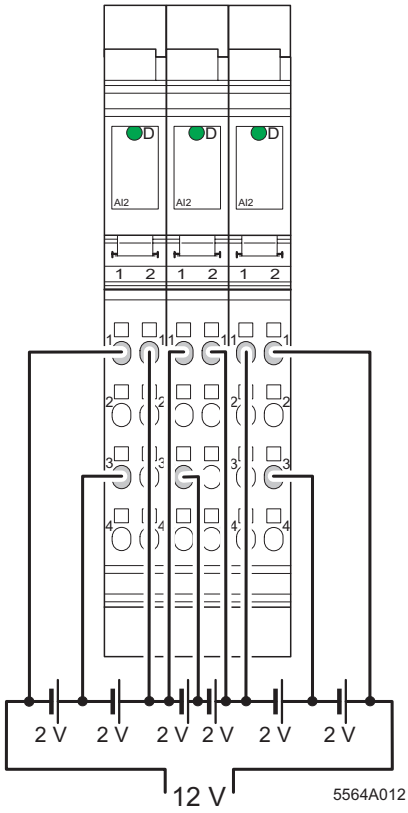

Figure 6 Connection for battery monitoring

Because of the single-ended inputs, the following connections are necessary:

Connect the reference input of a terminal between two voltage sources.

Channel 1 measures the first voltage source with opposite polarity. The measured value must be adapted in the control system to the polarity.

Channel 2 measures the second voltage source with correct polarity.

Configure the terminal to bipolar (±10 V).

10 Notes on Using the Terminal in Potentially Explosive Areas

10.1 Approval in Acc. With EG-RL 94/9 (ATEX) II 3G EEx nAC IIC T4 U

This Inline terminal conforms to standard EN 50021 and can be installed in a Zone 2 potentially explosive area. These Inline terminals are Category 3 items of equipment.

10.2 UL Approval

These Inline terminals for the indicated hardware version or later are suitable for use in Class I, Division 2, Groups A, B, C, D.

Before using an Inline terminal in a Zone 2 potentially explosive area, check that the terminal has been approved for installation in this area.

For a list of terminals that are approved for the potentially explosive areas of Zone 2, please refer to the AH EN IL EX ZONE 2 application note.

Check the labeling on the Inline terminal and the packaging (see Figure 7).

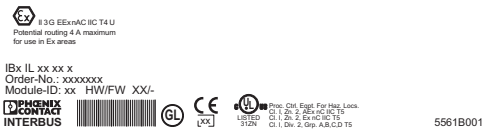

Figure 7 Example labeling of terminals for use in potentially explosive areas

Before startup, ensure that the following points and instructions are observed.

1. When working on the Inline terminal, always switch off the supply voltage.
2. The Inline terminal must only be installed, started up, and maintained by qualified specialist personnel.
3. Install the Inline terminals in a control cabinet or metal housing. The minimum requirement for both items is IP54 protection according to EN 60529.
4. The Inline terminal must not be subjected to any mechanical or thermal strain, which exceeds the limits specified in the product documentation.
5. The Inline terminal must not be repaired by the user. Repairs may only be carried out by the manufacturer. The Inline terminal is to be replaced by an approved terminal of the same type.
6. During operation, only Category 3G equipment must be connected to Inline terminals in Zone 2.
7. Observe all applicable standards (e.g., EN 60079) and national safety and accident prevention regulations for installing and operating equipment.

10.3 Restrictions

When using terminals in potentially explosive areas, observe the technical data and limit values specified in the corresponding documentation (user manual, data sheet, package slip).

Restrictions regarding the Inline system

The **maximum permissible current** flowing through potential jumpers U_M and U_S (total current) is limited to **4 A** when using the Inline terminals in potentially explosive areas.

11 Programming Data/Configuration Data

11.1 Local bus (INTERBUS)

ID code	$7F_{hex}$ (127_{dec})
Length code	02_{hex}
Input address area	4 bytes
Output address area	4 bytes
Parameter channel (PCP)	0 bytes
Register length (bus)	4 bytes

11.2 Other Bus Systems

For the programming data/configuration data of other bus systems, please refer to the corresponding electronic device data sheet (e.g., GSD, EDS).

12 Process Data

For the assignment of the illustrated (byte.bit) view to your INTERBUS control or computer system, please refer to data sheet DB GB IBS SYS ADDRESS, Order No. 9000990.

12.1 Process Data Output Words for the Configuration of the Terminal (see page 14)

(Word.bit) view	Byte	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Assignment	1	0	0	0	0	0	Filter		0	0	Format		Measuring range			
Channel 2	Assignment	1	0	0	0	0	0	Filter		0	0	Format		Measuring range			

12.2 Assignment of the Terminal Points to the Process Data Input Words (see page 16)

(Word.bit) view	Byte	Word 0															
	Bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
(Byte.bit) view	Byte	Byte 0								Byte 1							
	Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Channel 1	Signal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Terminal point 1.1: Voltage input Terminal point 1.2: Current input															
	Signal reference	Terminal point 1.3															
	Shielding (FE)	Terminal point 1.4															
Channel 2	Signal	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
		Terminal point 2.1: Voltage input Terminal point 2.2: Current input															
	Signal reference	Terminal point 2.3															
	Shielding	Terminal point 2.4															

12.3 Process Data Output Words

With the two process data output words you can configure each channel of the terminal independently. The following configurations are possible:

– Selecting a measuring range according to the input signal
– Switching off mean-value generation
– Changing the formats of the measured value representation

The configuration settings are not saved. It must be transmitted in each bus cycle.

After applying voltage (power up) to the Inline station, the "Measured value invalid" message (error code 8004_{hex}) appears in the process data input words. After 1 second, maximum, the preset configuration is accepted and the first measured value is available. If you change the configuration the corresponding channel is re-initialized. The "Measured value invalid" message (error code 8004_{hex}) appears in the process data output words for 100 ms, maximum.

Default:

Measuring range:	0 V to 10 V
Mean-value generation:	Enabled
Output format:	IL format

You cannot change the signal input type through the process data output words. Current or voltage measurement is selected by applying the measured signal to the current or voltage input.

In addition, select the corresponding measuring range through the process data output words.

Do not simultaneously apply current and voltage signals to an input channel as you will not receive valid measured values.

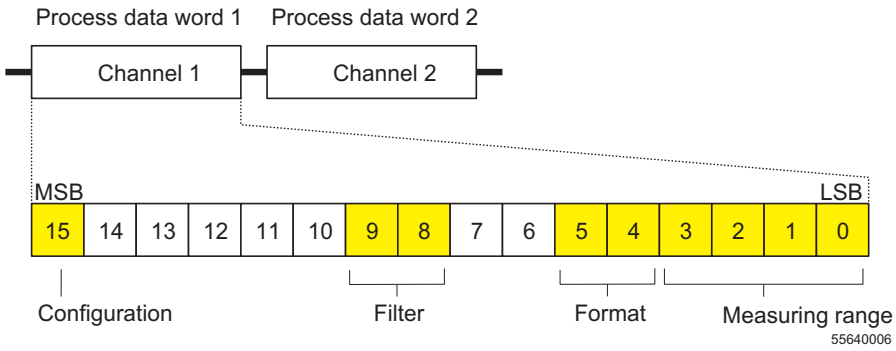

Figure 8 process data output words

MSB Most significant bit LSB Least significant bit

One process data output word is available for the configuration of each channel.

Set bit 15 of the corresponding output word to 1 to configure the terminal. If bit 15 = 0 the preset configuration is active.

Bit 15:

Code	Configuration
0	**Default**
1	Configuration data

Bit 9 and bit 8:

Code	Filter
00	**16-sample mean value (default)**
01	No filter
10, 11	Reserved

Bit 5 and bit 4:

Code	Format
00	**IB IL (15 bits) (default)**
01	IB ST (12 bits)
10	IB RT (15 bits)
11	Standardized display

Bit 3 to bit 0:

Code	Measuring Range (Voltage)
0000	**0 V to 10 V (default)**
0001	± 10 V
0010 through 0111	Reserved

Bit 3 to bit 0

Code	Measuring Range (Current)
1000	0 mA to 20 mA
1001	±20 mA
1010	4 mA to 20 mA
1011 to 1111	Reserved

Set all reserved bits to 0.

12.4 Process Data Input Words

The measured values are transmitted, per channel, to the controller board or the computer by means of the process data input words.

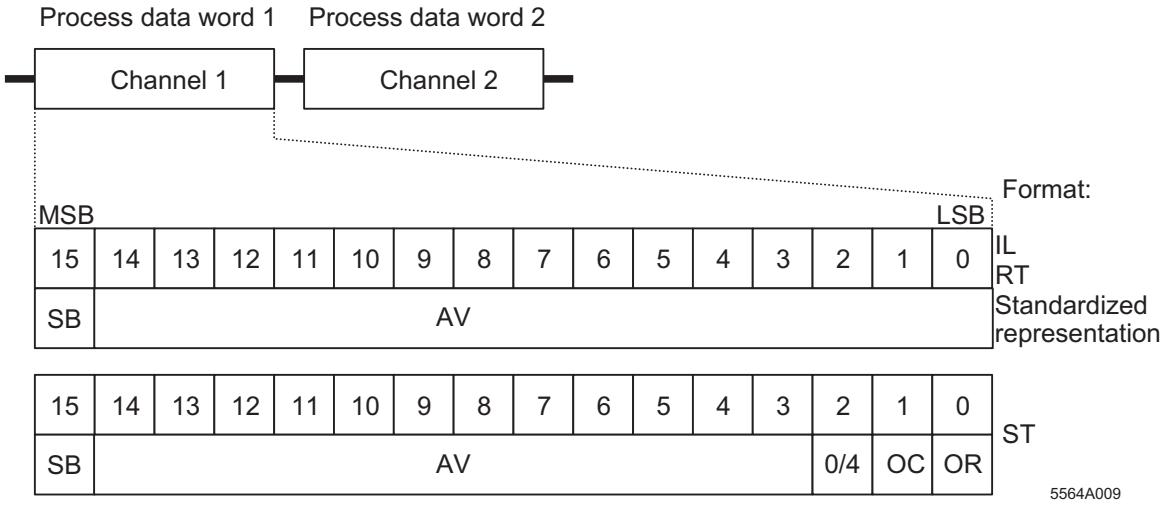

Figure 9 Sequence of the process data input words and display of the bits of the first process data word in the different formats

SB	Sign bit	OC	Open circuit
AV	Analog value	OR	Overrange
0/4	Measuring range 4 through 20 mA		
MSB	Most significant bit	LSB	Least significant bit

The "IB IL" and "standardized display" process data formats support extended diagnostics.
The following error codes are possible:

Code (hex)	Errors
8001	Overrange
8002	Open circuit
8004	Measured value invalid/no valid measured value available
8010	Configuration invalid
8040	Module faulty
8080	Underrange

13 Formats for Representing the Measured Values

13.1 "IB IL" Format

The measured value is represented in bits 14 through 0. An additional bit (bit 15) is available as a sign bit.

This format supports extended diagnostics. Values >8000_{hex} indicate an error. The error codes are listed on page 16.

Measured value representation in "IB IL" format (15 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV														

SB Sign bit AV Analog value

This format is preset (default). To ensure that the terminal can be operated in previously used data formats, the measured value representation can be switched to different formats.

13.2 Significant Measured Values

Some codes are used for diagnostic functions. Therefore, the resolution is not 15 bits but exactly 14.9886847 bits.

Measuring range 0 mA through 20 mA / 0 V through 10 V

Input Data Word (Two's Complement)		0 mA to 20 mA I_{Input}	0 V to 10 V U_{Input}
hex	**dec**	**mA**	**V**
8001	Overrange	> +21.6746	> +10.837
7F00	32512	+21.6746	+10.837
7530	30000	+20.0	+10.0
0001	1	+0.66667 µA	+333.33 µV
0000	0	0	0
0000	0	< 0	<0

Measuring range -20 mA through +20 mA / -10 V through +10 V

Input Data Word (Two's Complement)		-20 mA to +20 mA I_{Input}	-10 V to +10 V U_{Input}
hex	**dec**	**mA**	**V**
8001	Overrange	> +21.6746	> +10.837
7F00	32512	+21.6746	+10.837
7530	30000	+20.0	+10.0
0001	1	+0.66667 µA	+333.33 µV
0000	-1	0	0
FFFF	0	-0.66667 µA	-333.33 µV
8AD0	-30000	-20.0	-10.0
8100	-32000	-21.6746	-10.837
8080	Underrange	<-21.6746	<-10.837

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)		4 mA to 20 mA I_{Input}
hex	dec	mA
8001	Overrange	> +21.339733
7F00	32512	+21.339733
7530	30000	+20.0
0001	1	+4.00053333
0000	0	+4.0 to 3.2
8002	Open circuit	<+3.2

13.3 "IB ST" Format

The measured value is represented in bits 14 through 3. The remaining 4 bits are available as sign, measuring range and error bits.

This format corresponds to the data format used on INTERBUS ST modules.

Measured value representation in "IB ST" format (12 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV												0/4	OC	OR

SB	Sign bit	OC	Open circuit
AV	Analog value	OR	Overrange
0/4	Measuring range 4 through 20 mA		

13.4 Significant Measured Values

Measuring range 0 mA through 20 mA / 0 V through 10 V

Input Data Word (Two's Complement)	0 mA to 20 mA I_{Input}	0 V to 10 V U_{Input}
hex	mA	V
7FF9	>21.5	>10.75
7FF8	20.0 to 21.5	10.00 to 10.75
7FF8	19.9951	9.9975
4000	10.0	5.0
0008	0.0048828	0.002441
0000	0	0

Measuring range -20 mA through +20 mA / -10 V through +10 V

Input Data Word (Two's Complement)	-20 mA to +20 mA I_{Input}	-10 V to +10 V U_{Input}
hex	mA	V
7FF9	>21.5	>10.75
7FF8	20.0 to 21.5	10.00 to 10.75
7FF8	19.9951	9.9975
0008	0.0048828	0.002441
0000	0	0

Input Data Word (Two's Complement)	-20 mA to +20 mA I_{Input}	-10 V to +10 V U_{Input}
hex	mA	V
FFF8	-0.0048828	-0.002441
8000	-20.0 to -21.5	-10.00 to -10.75
8001	<-21.5	<-10.75

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)	4 mA to 20 mA I_{Input}
hex	mA
7FFD	>21.5
7FFC	20.0 to 21.5
7FFC	19.9961
000C	4.003906
0004	3.2 to 4.0
0006	<3.2

13.5 "IB RT" Format

The measured value is represented in bits 14 through 0. An additional bit (bit 15) is available as a sign bit.

This format corresponds to the data format used on INTERBUS RT modules.

In this data format error codes or error bits are not defined. An open circuit is indicated by the positive final value $7FFF_{hex}$.

Measured value representation in "IB RT" format (15 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV														

SB Sign bit AV Analog value

13.6 Significant Measured Values

Measuring range 0 mA through 20 mA / 0 V through 10 V

Input Data Word (Two's Complement)	0 mA to 20 mA I_{Input}	0 V to 10 V U_{Input}
hex	mA	V
7FFF	≥ 19.999385	≥ 9.999695
7FFE	19.9987745	9.999939
4000	10.0	5.0
0001	0.6105 µA	305.0 µV
0000	≤ 0	≤0

Measuring range -20 mA through +20 mA / -10 V through +10 V

Input Data Word (Two's Complement)	-20 mA to +20 mA I_{Input}	-10 V to +10 V U_{Input}
hex	mA	V
7FFF	≥ +19.999389	≥ +9.999939
7FF7	+ 19.998779	+9.99939
4000	+10.0	+5.0
0001	+0.61035 µA	+305.0 µV
0000	0	0
FFFF	-0.61035 µA	-305.0 µV
8001	-19.999389	-9.99939
8000	≤-20.0	≤-10.0

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)	4 mA to 20 mA I_{Input}
hex	mA
7FFF	≥ 19.9995116
7FFE	19.9990232
4000	12.0
0001	0.4884 µA
0000	4.0
0000	3.2 to 4.0
7FFF	< 3.2

13.7 "Standardized Display" Format

The data is represented in bits 14 through 0. An additional bit (bit 15) is available as a sign bit.

In this format, data is standardized to the measuring range and represented in such a way that it indicates the corresponding value without conversion. In this format one bit has the value of 1 mV or 1 µA.

This format supports extended diagnostics. Values >8000_{hex} indicate an error. The error codes are listed on page 16.

Measured value representation in "standardized display" format (15 bits)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
SB	AV														

SB Sign bit AV Analog value

13.8 Significant Measured Values

Because of the display standardization not all of the possible codes are used. Some codes are additionally used for diagnostic functions. Therefore, the resolution is not 15 bits but exactly 13.287713 bits.

Measuring range 0 V through 10 V

Input Data Word (Two's Complement)		0 V to 10 V U_{Input}
hex	dec	V
8001	Overrange	>+10.837
2A55	10837	+10.837
2710	10000	+10.0
0001	1	+0.001
0000	0	≤0

Measuring range 0 mA through 20 mA

Input Data Word (Two's Complement)		0 mA to 20 mA I_{Input}
hex	dec	mA
8001	Overrange	>+21.674
54AA	21674	+ 21.674
4E20	20000	+20.0
0001	1	+ 0.001
0000	0	≤ 0

Measuring range -10 V through +10 V

Input Data Word (Two's Complement)		-10 V to +10 V U_{Input}
hex	dec	V
8001	Overrange	>+10.837
2A55	10837	+10.837
2710	10000	+10.0
0001	1	+ 0.001
0000	0	0
FFFF	-1	- 0.001
D8F0	-10000	-10.0
D5A6	-10837	-10.837
8080	Underrange	<-10.837

Measuring range -20 mA through +20 mA

Input Data Word (Two's Complement)		-20 mA to +20 mA I_{Input}
hex	dec	mA
8001	Overrange	>+21.674
54AA	21674	+ 21.674
4E20	20000	+20.0
0001	1	+ 0.001
0000	0	0
FFFF	-1	- 0.001
B1E0	-20000	-20.0
A656	-21674	-21.674
8080	Underrange	<21.674

Measuring range 4 mA through 20 mA

Input Data Word (Two's Complement)		4 mA to 20 mA I_{Input}
hex	**dec**	**mA**
8001	Overrange	> 21.339
43BB	17339	21.339
3E80	16000	20.0
0001	1	4.001
0000	0	4.0 to 3.2
8002	Open circuit	<3.2

13.9 Example

Measured value representation in different data formats.

Measuring range: 0 mA to 20 mA

Measured value: 10 mA

Input data word:

Format	hex Value	dec Value	Measured Value
IB IL	3A98	15 000	10 mA
IB ST	4000	16 384	10 mA
IB RT	4000	16 384	10 mA
Standardized display	2710	10 000	10 mA

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